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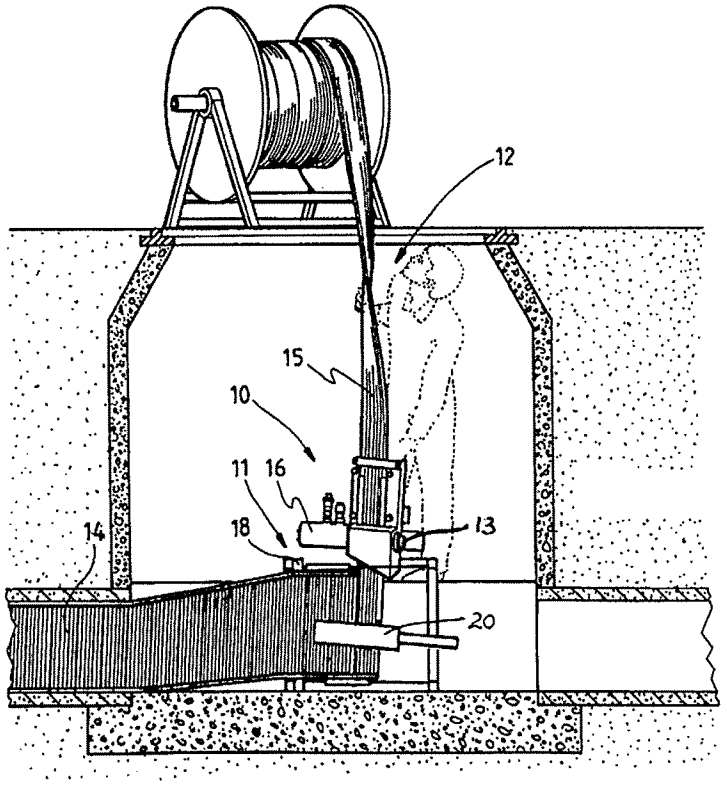
(54) Title: IMPROVED MEANS AND METHOD FOR LINING UNDERGROUND PIPES USING A SPIRALLY WOUND PLASTIC STRIP

(57) Abstract

The invention provides an improved means and method for lining underground pipes utilising an oval shaped winding head or cage (11) comprised of an annulus of spacially located roller (16) located at the base of a manhole (12) which provides access to the pipe to be lined, wherein the annulus has an inner circumference which approximately equals the inner circumference of the pipe to be lined. A resilient plastic strip (15) is fed into the winding head (11) so as to form a helically wound liner tube (14) which exits from the winding head having a non–circular shape. The wound liner tube is advanced towards the open leading end of the pipe and is allowed to transform to a generally circular shape prior to its entry into the pipe, with the diameter of the circular pipe being approximately equal to the inner diameter of the pipe to be lined.



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# IMPROVED MEANS AND METHOD FOR LINING UNDERGROUND PIPES USING A SPIRALLY WOUND PLASTIC STRIP

This invention relates to an improved means and method for lining pipes, especially underground pipes such as sewer pipes, using a spirally wound strip of plastics material in order to form a liner tube.

Machines for producing spirally wound plastics tube or piping and comprising a winding head or roller cage formed by an annulus of rollers designed to curve a plastic strip or profile into a helical form when driven into the annulus by drive means, are well known in the art. In this regard reference is made to Australian Patent Specification Nos 530251 and 562309 for inventions entitled "Forming Tubes From Strip (Helically)" and "Helically Wound Pipe Winding Machine" respectively, issued to Rib Loc Hong Kong Limited.

When these machines are used for relining failed or damaged underground sewer pipes, the procedure has been to lower a machine downwardly into a manhole so that it sits on the invert of the sewer pipe at the base or bottom of the manhole. The plastic liner strip is then fed down the manhole into the machine and spirally wound to create a liner tube or pipe which advances along the failed sewer pipe to line same.

It will be realised that the size of the roller cage of the winding machine is governed by the size of the invert or channel at the bottom of the manhole which has a maximum transverse width equal to the diameter of the pipe to be lined. The cage frame must of course be sized so that it sits within the base of the manhole. Since the diameter of the wound liner tube (unexpanded) is determined by the inner diameter of the winding machine roller cage, and since also the overall dimensions of the pipe winding machine must be smaller than the width of the invert or channel, it is not uncommon therefore for the diameter of the finished liner pipe to be up to 60mm smaller than the inner diameter of the pipe being relined.

One known method to produce a liner pipe having a diameter more closely matching the inner diameter of the original pipe being relined, involves widening the invert at the bottom of the manhole by scabbling out some of the concrete, eg by means of a jack hammer, so as to effectively increase the width of the area in which the winding machine is located. This allows the size of the roller cage of the winding machine to be increased so that its inner diameter is closer to that of the pipe being relined. In situations, however, where only a very short run of liner pipe is required, the time and effort spent in carrying out alterations to the manhole is extremely inefficient, particularly in terms of time and cost.

It is also known to spirally wind a plastic strip with interlocking edges into a failed pipe to create a circular liner tube which can then be made to expand by mechanical means, so that the liner tube makes contact against the inner surface of the pipe being relined. This, however, requires a slip joint between the interlocking edges of the liner strip. In this regard, reference is made to US Patent No. 4995929 (Rib Loc).

It is the main object of the present invention to provide an improved pipe relining method and means which allows a failed sewer pipe to be lined with a helically wound liner pipe or tube having a diameter which more closely matches the diameter of the pipe being relined, in a very simple and cost effective manner. In particular, the method of the present invention avoids the need to alter the size of the manhole at its base so as to accommodate an "oversize" winding cage of the pipe winding apparatus, and preferably, also the need to expand the wound liner tube, after being fed into the pipe being relined, to a larger diameter so that it more closely matches the diameter of the pipe being relined.

Broadly according to this invention, a method of lining an underground failed sewer pipe with a helically wound liner tube formed from a resilient plastics strip, comprises the steps of:

locating a pipe winding machine having a winding head at the base of a man-hole which provides access to the pipe to be lined, so that the winding head is generally horizontally aligned with the pipe, said winding head comprising an annulus of spatially located rollers, said annulus having a major axis and a minor axis and defining a non-circular shape, said annulus having an inner circumference which approximately equals the inner circumference of the pipe to be relined,

operating the winding machine to produce an helically wound liner tube of non-circular shape, with the outer circumference of the non-circular liner tube being approximately equal to the inner circumference of the pipe to be lined,

advancing the wound liner tube horizontally towards the open leading end of the pipe, and

allowing the non-circular shaped liner tube to transform to a generally circular shape during the advancing step prior to its entry into said leading end of the pipe.

Also according to this invention, there is provided pipe winding apparatus for lining an underground pipe, eg a failed sewer pipe, with a helically wound tubular liner formed from a plastics strip, comprising a winding head which includes an annulus of rollers arranged to curve the plastics strip to a helical form with the edges of the strip being joined together during the winding procedure, characterised in that the annulus of rollers of the winding head is approximately oval in shape (instead of being circular), whereby, during the winding process, an oval-shaped liner tube or pipe is produced which, after exiting from the winding head, takes on an unconstrained circular shape having an outer diameter which closely matches the inner diameter of the pipe being relined.

In practice it has been found that the oval-shaped liner tube, which is in a tensioned state as it exits from the winding head, will alter to a generally circular shape a short distance after the liner tube exits from the winding head. Therefore, only a small

gap is required between the exit end of the winding cage and the leading open end of the pipe to be relined.

Desirably, the oval-shaped winding head is oriented so that, when the machine is installed at the bottom of the manhole, the major axis of the roller annulus extends approximately vertically, ie approximately parallel to the axis of the manhole opening, with the height of the annulus measured along its major axis being dimensioned so that it is greater than the inner diameter of the pipe being relined. It will of course be appreciated that the design of the manhole and its invert imposes a size limitation on the transverse width of the winding head but not its height. This allows an "oversized" oval-shaped liner tube to change, when in an unconstrained condition, to a tube of circular shape having a diameter that is close to the maximum size of what is required.

Preferably the winding head is designed in such a way so that its peripheral shape can be varied from non-circular, eg oval or egg-shaped, to a circular shape, by means of flexible joints spaced around its periphery. This allows the cage, when dropped into the invert or channel at the bottom of the manhole, to conform to the cross-sectional shape of the invert or channel.

Desirably, the winding head is constructed in a way which allows the diameter of the liner tube to be varied, whereby it can be used for producing liner tubes for failed sewer pipes of different diameters.

In accordance with another aspect of the present invention, the liner tube or pipe, upon exiting from the winding head, is reinforced with outer windings of metal (or plastic) reinforcing bands that are preformed to an oval or egg-shape whereby, the finished pipe assembly permanently retains an oval-shape. Such an arrangement would not, however, be used in the relining of underground sewer pipes - except if

done in a situation where lengths of wound pipe can be created remote from the sewer location and then subsequently pulled into an oval-shape pipe.

In order to more fully explain the present invention, several embodiments are described hereunder in some further detail with reference to and as illustrated in the accompanying drawings wherein:

Fig 1 is a somewhat schematic elevational view of a typical spiral pipe winding head which is circular in shape, according to known art;

Fig 2 is a view similar to Fig 1 showing a winding head or roller cage constructed according to the present invention;

Fig 3 is a schematic sectional view showing the winding machine located at the base of the manhole and which progressively winds the liner tube in-situ and advances same into the underground pipe for relining the pipe;

Fig 4 is a fragmentary perspective view of the winding machine shown in Fig 3;

Fig 5 is an end view of the liner tube after it has exited from the winding head, showing the circular shape which it assumes when unconstrained, while

Fig 6 is a view similar to Fig 2 showing a winding head according to a second embodiment of the invention (the feed-in assembly for the liner strip being omitted for sake of clarity).

Referring to Figs 2-5 of the accompanying drawings, there is shown a pipe winding machine 10 which includes a winding head 11 arranged to be located at the base of a manhole 12 which connects to a sewer pipe which is to be relined with a helically wound liner tube 14 produced by the winding apparatus 10. The helically wound liner tube 14 is formed from a resilient plastics ribbed strip 15 which is fed down through the manhole 12 and in turn fed, by drive rollers 13, at an adjustable angle approximately tangentially into the winding head 11 which, by means of an annulus

of elongate rollers 16, curves the strip 15 to a helical form with the edges of the strip 15 overlapping one another and being locked together. The angle (ie formed with respect to the longitudinal axis of the head 11) at which the strip is fed into the head 11, will depend on the width of the strip 15 and the diameter of the pipe to be produced. This procedure is well known in the art.

The pipe winding head 11 includes a pair of spaced apart parallel annular end plates or discs 18 between which are rotatably mounted the rollers 16, the rollers being supported on shafts which are journalled for rotation in bearings carried by the end plates 18. The rollers are driven by means of a chain or belt drive system (not shown) which again is known in the art.

Some of the rollers 16 have a series of circumferential ribs 19 to match the corrugations of the strip 15 being formed into the tube 14, such corrugations being formed between adjacent longitudinal T-shaped ribs on the outer surface of the strip 15. This is designed to guide the strip 15 around its helical path.

In accordance with a feature of the present invention, the winding head 11 is approximately oval-shaped (or egg-shaped) having a vertical major axis and a transverse minor axis which extends perpendicularly (or nearly so) to the longitudinal axis of the pipe being relined. The winding head annulus 11 is sized so that its height measured along its major axis between opposite inner edges is slightly greater than the inner diameter of the pipe being relined, while the inner width of the winding head 11 measured along its transverse minor axis, is less than the inner diameter of pipe. It will of course be appreciated that while the maximum width of the winding head 11 is restricted to the width of the invert 13 at the bottom of the manhole 12, there is no such constraint for the height or depth of the head 11 due to the vertical opening created by the manhole 12.

Due to the non-circular shape of the winding head 11, the angle at which the strip 15 is fed into the cage 11 needs to be varied during the winding process. In this embodiment this is achieved by a sensor (not shown) which measures the winding angle and transmits a signal to an adjustment mechanism which adjusts the angle of the strip with respect to the longitudinal axis of the winding head or cage 11, thereby ensuring that the strip 15 is accurately fed into the head 11 and also that the locking or joining roller 20 which presses the overlapping edges of the strip together in interlocking relationship, is properly orientated relative to the strip being wound.

In this embodiment, the size and shape of the winding head 11 is selected so that the inner circumference of the roller annulus 11 is approximately equal to the inner circumference of the pipe to be lined. Thus when the oval-shaped liner tube 14 exits from the winding head 11 and is in an unconstrained condition, its oval-shape changes to a circular shape, the diameter of which approximately matches the inner diameter of the pipe being relined. In this way, the effective diameter of the relined pipe is not significantly different to the diameter of the original failed pipe.

In this embodiment, the liner forming strip 15 is made of a suitable resilient PVC plastics material, but of course other plastics materials can be used, and is provided with T-shaped ribs on its outer surface, its inner surface being smooth.

In practice, it has been found that the liner tube 14 changes from its exiting oval-shaped cross-section to a generally circular cross-sectional shape within approximately 300mm from the exit end of the winding head 11. Thus, the winding head 11 is located so that its exit end is spaced at least 300mm from the open leading end of the pipe to be relined. If such clearance cannot be achieved, it will be necessary for the operator to ensure that the leading end of the liner tube 14 is forced into the entry end of the pipe upon start-up of the lining operation.

The shape change which occurs with the liner tube 14 is due to the resilient nature of the plastics liner strip 15 and also the equalisation of the bending stresses around the circumference of the liner tube after exiting the winding head 11. It will be appreciated that as the plastics strip 15 is helically curved within the winding head 11, bending stresses are imparted to it; however, such bending stresses, when the wound liner tube is free from the constraints of the rollers 16, will tend to equalise or balance themselves around the circumference of the tube resulting in a shape transformation from oval to circular. In an un-constrained state, the liner tube will assume a generally circular shape.

As shown in Fig 4, the winding head 11 comprises end plates 18 which are themselves oval-shaped. With this arrangement, however, the size of the helically wound liner tube is fixed and cannot be varied. Consequently for other diameters of sewer pipes to be relined, the entire winding head 11 must be replaced with another head dimensioned so that its oval-shaped annulus produces a liner tube of the desired diameter.

In the embodiment shown in Fig 6 of the accompanying drawings, the head 30 is constructed in such a way that the actual diameter of the liner tube to be created can be varied, and thereby enable the head 30 to be used to reline sewer pipes of different diameters. This is achieved by utilising endless link chains 31 (in lieu of the end plates 18), each of which is made up of a series of pivotally interconnected rigid chain link members 32, the pivotal joints between adjacent link members 32 enabling the head 30 to readily change its shape as required and, if necessary, locked in that configuration. Thus, when the head 30 is dropped into the channel 33 at the bottom of a manhole 34, it is able to change its cross-sectional shape and conform to the shape required to fit within the channel 33.

A further advantage of the chain link winding head is that by adding or removing one or more of the link members and associated rollers, the size of the head can be changed to in turn change the diameter of the liner tube to be wound.

In another non-illustrated embodiment of the invention, the oval-shaped liner tube is reinforced with preformed oval-shaped metal reinforcing bands whereby the finished composite pipe will permanently retain its oval cross-sectional shape (the reinforcing bands serving to retain the wound liner tube in a tensioned oval-shaped condition). It will of course be appreciated that by varying the shape of the preformed reinforcing bands, the cross-sectional shape of the finished composite pipe can in turn be varied. The metal bands are helically wound around the liner tube as the liner tube is formed, with the edges of the band interlocking with the flanges of the outstanding ribs on the outer surface of the liner tube - a procedure which is already known in the art.

It will also be realised that a shape other than oval (or egg-shape) for the winding head could be utilised in order to carry out the invention. For example, a multi-lobed ring shape could be used, but this will depend on the character of the pipe to be lined.

A brief consideration of the abovedescribed embodiments will indicate that the invention provides a very simple, yet extremely effective, modification to existing helically wound pipe winding machines which allows failed sewer pipes to be relined with a plastics liner tube which is sized so that the relined sewer pipe has a diameter not significantly different to the diameter of the original failed pipe - without the need to expand the liner tube by mechanical means.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A method of lining an underground pipe with a helically wound liner tube formed from a resilient plastics strip, comprising the steps of:

locating a pipe winding machine having a winding head at the base of a man-hole which provides access to the pipe to be lined, so that the winding head is aligned lengthwise (or nearly so) with the pipe, said winding head comprising an annulus of spatially located rollers arranged to curve the strip to a helical form within the annulus of the rollers, said annulus having a major axis and a minor axis and defining a non-circular shape, said annulus having an inner circumference which approximately equals the inner circumference of the pipe to be relined,

operating the winding machine to produce an helically wound liner tube of non-circular shape, with the outer circumference of the non-circular liner tube being approximately equal to the inner circumference of the pipe to be lined,

advancing the wound liner tube horizontally towards the open leading end of the pipe, and

allowing the non-circular shaped liner tube to transform to a generally circular shape during the advancing step prior to its entry into said leading end of the pipe.

2. A method according to claim 1 wherein the wound non-circular liner tube exits from the winding head with its major axis extending upwardly.

3. A method according to claim 1 or claim 2 wherein said annulus is approximately oval-shaped whereby the wound liner tube produced by the winding head is similarly oval-shaped.

4. A method according to anyone of claims 1 to 3 wherein the liner tube advances through a gap between the exit end of the winding head and the open leading end of the pipe being relined, in a unconstrained condition.

5. A method according to claim 4 wherein the gap is in the order of 300mm.

6. A method according to anyone of claims 1 to 5 wherein the winding head annulus is sized so that its height measured along its major axis between opposite inner edges thereof is slightly greater than the inner diameter of the pipe to be relined, and wherein the inner width of the winding head annulus measured along its transverse minor axis is less than the inner diameter of the pipe.

7. A method according to any one of the preceding claims wherein the resilient plastics strip is fed in the winding direction into the winding head to form a series of convolutions, adjacent edges of which overlap one another and are lockingly interconnected, said locking interconnection being effected by co-operable male and female locking edge formations extending along opposite sides of the strip.

8. Apparatus for lining an underground pipe, eg a failed sewer pipe, with a helically wound liner tube formed from a resilient plastics strip, comprising a winding head which includes an annulus of rollers, the axis of which extends generally longitudinally of the liner tube being wound, said rollers being arranged so as to curve the plastics strip to a helical form with the edges of the strip being lockingly interconnected during winding, characterised in that the annulus of rollers of the winding head is approximately oval-shaped having a major axis which extends in an upwards direction and a minor transverse axis, whereby, during winding, an oval-shaped liner tube or pipe is produced which, after exiting from the winding head, is in an unconstrained state and changes to a generally circular shape having an outer diameter which closely matches the inner diameter of the pipe being relined.

9. Apparatus according to claim 8 wherein said winding head annulus is sized so that its height measured along its major axis between opposite inner edges thereof

is slightly greater than the inner diameter of the pipe being relined, with the inner width of said winding head annulus measured along its transverse minor axis being less than the inner diameter of said pipe.

10. Apparatus according to either claim 8 or claim 9 wherein the winding head annulus is sized so that its inner circumference is approximately equal to the inner circumference of the pipe to be lined.

11. Apparatus according to any one of the preceding claims wherein said winding head comprises a pair of spaced apart parallel annular end support plates each of which is oval-shaped with its major axis extending vertically, said rollers extending between said end plates and each being rotatable about its respective longitudinal axis, wherein the axes of the rollers extend generally longitudinally of the axis of the winding head.

12. Apparatus according to claim 11 wherein each said roller is supported on a shaft, the opposite ends of which are journalled for rotation in bearings respectively carried by said end plates.

13. Apparatus according to claim 12 wherein the winding head further comprises drive means for driving at least some of said rollers.

14. Apparatus according to claim 13 wherein said rollers are positioned at an oblique angle relative to the longitudinal axis of the winding head between said end support plates, the oblique angle corresponding with a pitch angle of the strip to be helically wound.

15. A method of lining an underground pipe with a helically wound liner tube formed from a resilient plastics strip, substantially as hereinbefore described, with reference to and illustrated in Figures 2 to 6 of the accompanying drawings.

16. Apparatus for lining an underground pipe with a helically wound liner tube formed from a resilient plastics strip, substantially as hereinbefore described, with reference to and illustrated in Figures 2 to 6 of the accompanying drawings.

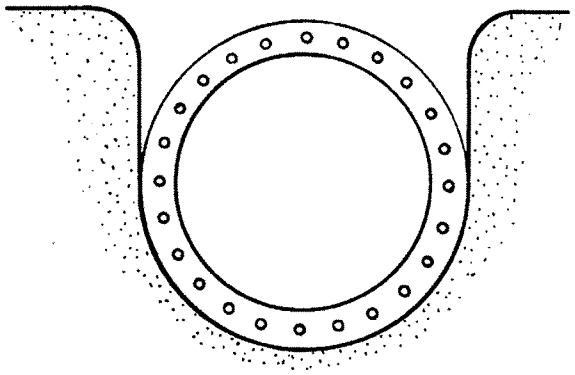

FIG 1

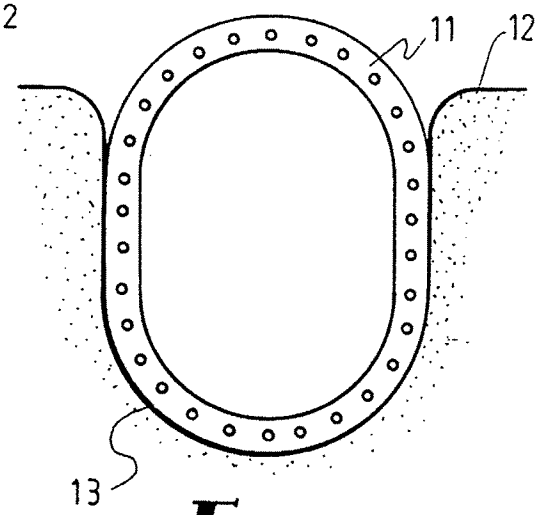


FIG 2

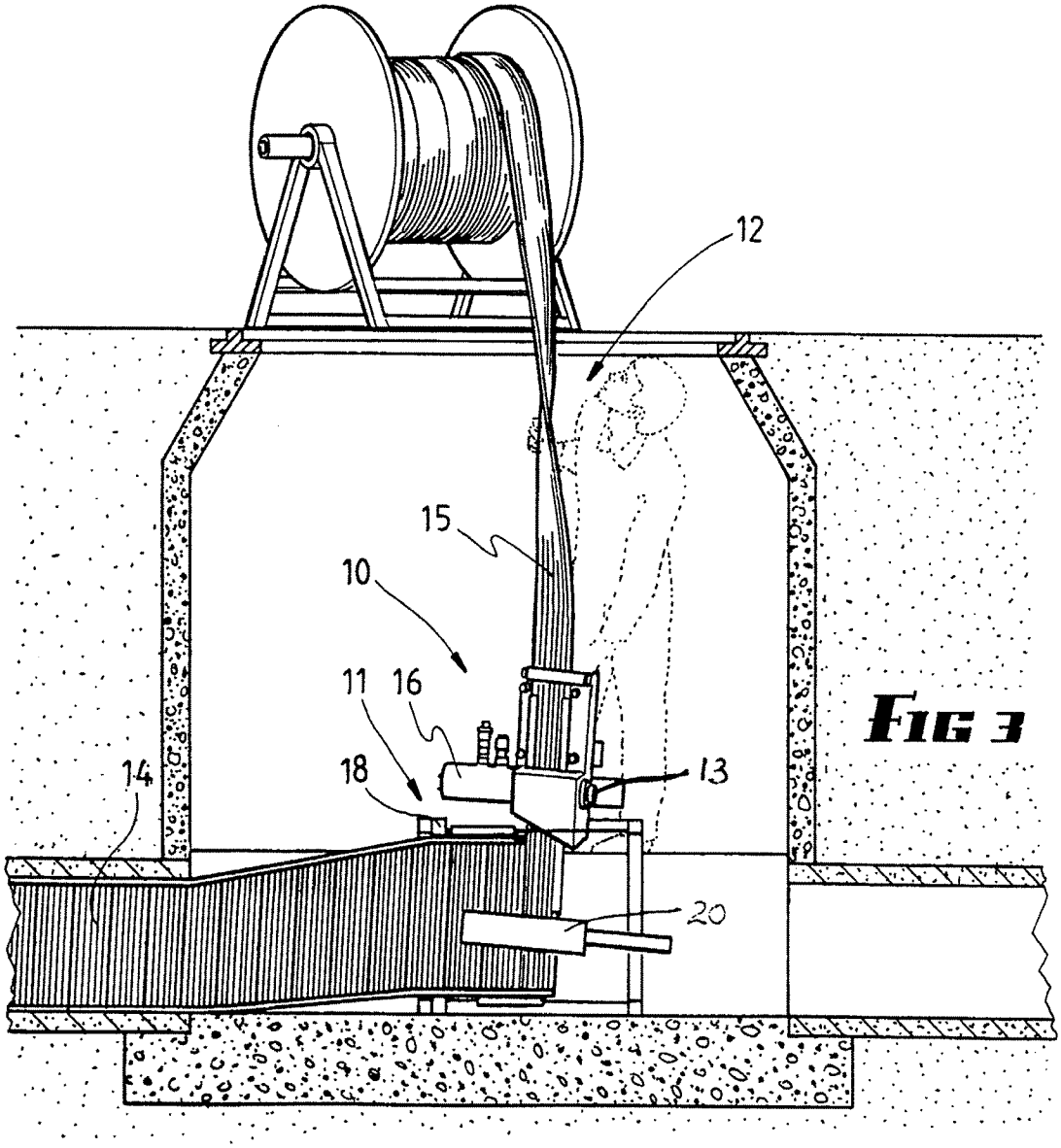


FIG 3

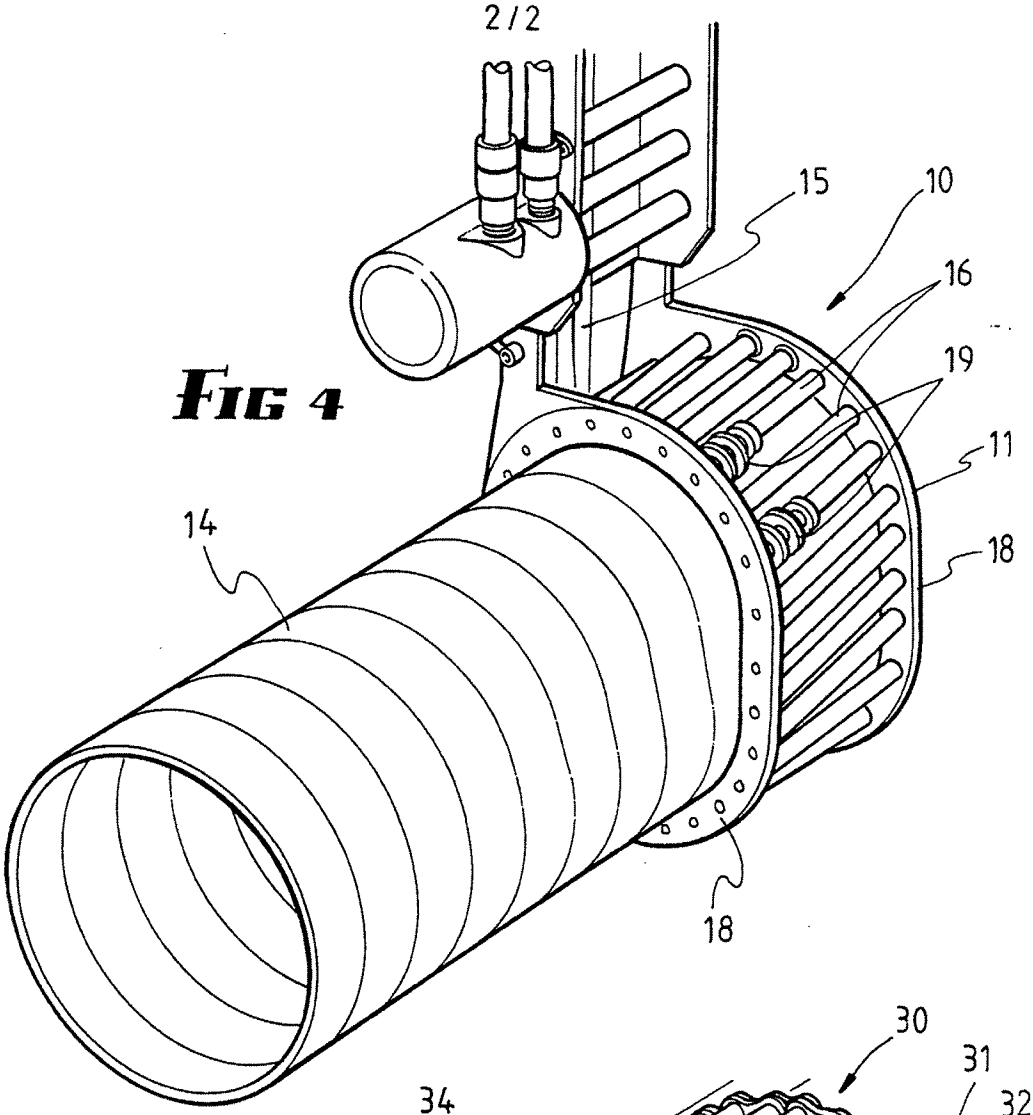


FIG 4

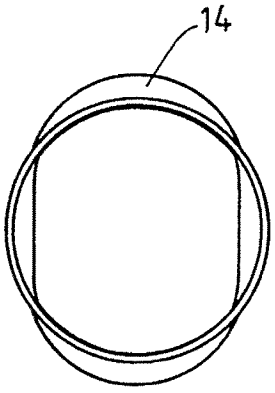


FIG 5

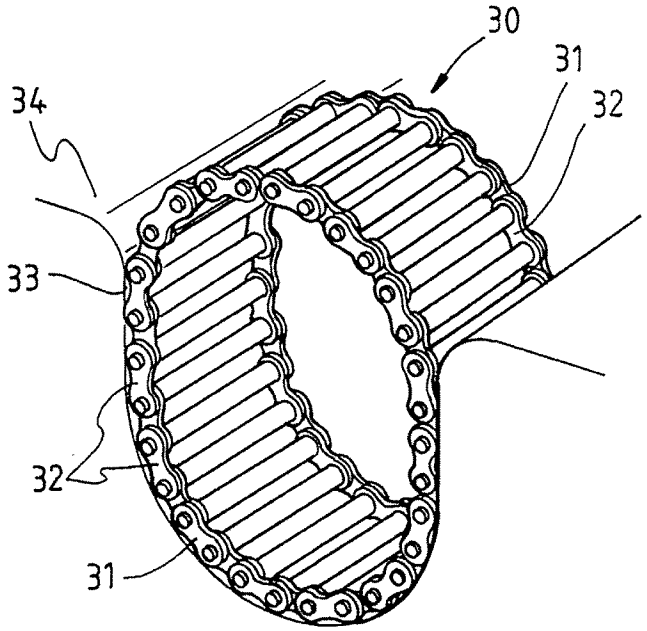


FIG 6

# INTERNATIONAL SEARCH REPORT

International Application No.
**PCT/AU 98/00058**

**A. CLASSIFICATION OF SUBJECT MATTER**

Int Cl[6]: B21C 37/12; B29C 63/32; E03F 3/06; F16L 55/16, F16L 55/18, F16L 57/00

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**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)
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**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| A | WO 89/11060 A1 (RIB LOC AUSTRALIA) 16 November 1989 | 1-16 |
| A | WO 89/01588 A1 (RIB LOC AUSTRALIA) 23 February 1989 | 1-16 |
| A | Derwent Abstract Accession No: 88-124223, Class Q42, JP 63-069620 A (SEKISUI CHEM IND) 29 March 1988 | 1-16 |
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| Patent Document Cited in Search Report | | Patent Family Member | | | | | |
|---|---|---|---|---|---|---|---|
| WO | 89/11060 | AU | 35594/89 | EP | 0418257 | JP | 1280510 |
| | | US | 5101863 | | | | |
| WO | 89/01588 | AU | 23238/88 | DK | 413/90 | EP | 379493 |
| | | NO | 900739 | US | 5074943 | | |
| JP | 63069620 | NONE | | | | | |
| WO | 87/05677 | AU | 72040/87 | CA | 1309333 | DD | 255579 |
| | | DK | 6025/87 | EP | 262183 | FI | 875033 |
| | | GR | 870455 | HK | 1127/93 | IN | 167882 |
| | | NO | 874790 | NZ | 219615 | PT | 84520 |
| | | TR | 23936 | US | 4995929 | ZA | 8701966 |

END OF ANNEX